SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number	**:** TU1403
STSM title	**:** ECO-DESIGNED APPROACH- Designing Adaptive Facades with a unified and systematic characterization.
STSM start and end date	**:** 11/07/2017 to 26/07/2017
Grantee name	**:** Nitisha Vedula

PURPOSE OF THE STSM:

Under Working Group 1: D.1.1. Report on progress made in new adaptive technologies over the course of the action, the Short Term Scientific Mission will be dealing with: Eco-designed approach- Designing Adaptive Facades with a unified and systematic characterization. Following mentioned are the aims and objectives of the 15 days Short-Term Scientific Mission (STSM):

- Analyzing the existing matrix of 45 projects dealing with Adaptive Façade Systems from the data base of COST Action TU1403 – Adaptive Façades Network.
- Evaluating and refining the 'Classification of Technologies and components involved in Adaptive Façade Systems'; with respect to the previously investigated information on new approaches and technologies.
- Developing an outline for a new approach that aims to combine the strong elements of already existing classification schemes.
- Analyzing where development of Adaptive Façade Systems can be improved with a holistic approach, with investigation and implementation of high-potential innovative components, materials, control systems in the course of the action. The prime concern of the objective is: Overall performance of the adaptive façade system with respect to usability and acceptance by the users.
- Documenting the novel concepts and technologies for Adaptive Façade Systems and to identify the emerging trends and research topics that are defying the future façade technologies.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM:

ECO-DESIGNED APPROACH - DESIGNING ADAPTIVE FACADES WITH A UNIFIED AND SYSTEMATIC CHARACTERIZATION.

The Short Term Scientific Mission; is dealing with understanding **the sustainability targets** for the performance of the adaptive building skin.

- **STEP: 1**
  Research and analysis of the previously analyzed database of 45 adaptive façade projects from Cost Action TU 1403-Adaptive Façade Network. Where, it already analyzed the function of the façade, in relation to external factors and user comfort inside the building.

- **STEP:2**
  Understanding the future sustainable targets of adaptive façade systems;
  Refinement and development of the already existing classification scheme for the various adaptive façade systems. Wherein, the development will be primarily focusing on an Eco-designed approach.

- **STEP: 3**
  Outline a new holistic approach in the field of Adaptive Façade Systems; involving the strong elements of already existing and scattered classification scheme.

- **STEP: 4**
  Inference; compiling and evaluating the Adaptive Façade Projects under the matrix developed with this new holistic approach.

- **STEP: 5**
  Contribute to the content of Educational Pack; related to the novel technologies and case-studies.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

ECO-DESIGNED APPROACH - DESIGNING ADAPTIVE FACADES WITH A UNIFIED AND SYSTEMATIC CHARACTERIZATION.

- **STEP: 1**
  Research and analysis of the previously analyzed database of 45 adaptive façade projects from Cost Action TU 1403-Adaptive Façade Network:
  The following projects where sought for achieving the final outcome for future sustainable targets:
  1. Oval Cologne Offices (Location: Cologne, Germany).
  2. Altra Sede Regione Lombardia (Location: Milan, Italy).
  3. Articulated cloud Pittsburg Children Museum (Location: Pittsburg, USA).
  4. ES Viagens Building/ PT Building (Location: Lisbon, Portugal)
  5. Campus Kolding, SDU University (Location: Kolding, Denmark)
  6. Allianz Headquarters (Location: Wallisellen, Switzerland)
  7. Media-TIC (Location: Barcelona, Spain)
  8. KfW Westarkade (Location: Frankfurt, Germany)
  9. WaMaFat - Switchable Insulation (Location: Ludwigshafen, Germany)

- **STEP:2**
  Understanding the future sustainable targets of adaptive façade systems:
  The aim of this scientific mission is to understand the future sustainable targets; engrosses a more elementary thought process which leads to an ECO-DESIGNED APPROACH.

Eco-designed approach: DEFINITION

It is the use of ecological design principles and strategies to design our built environment and our ways of life so that they integrate benignly and seamlessly with the natural environment that includes biosphere. [YEANG, Ken: Eco Design: A Manual for Ecological Design].

The basis of Eco-designed approach: THE ECOSYSTEM

An eco-system is a self-sufficient and independent unit in nature. It includes living things (plants, animals, decomposers), and their non-living environment (soil, air, water). Which needs only the input of solar energy for its functioning.

The components of Eco-System are as follows:

1. *Abiotic Components*: include the physical environment like soil, water, air along with the inorganic substances like CO_2, Nitrogen, O_2, Water, Phosphorus, Sulphur, Sodium, Potassium, Calcium, etc. Also, the climatic factors like light, temperature, pressure and humidity.
2. *Biotic Components*: is a community of inter-dependent living organisms:
   A. Producers: which synthesis their own food. E.g. Green Plants.
   B. Consumers: which are dependent on others for food. E.g. Human beings.
   C. Decomposers: which consume the dead remains and produce raw material needed for the Producers.

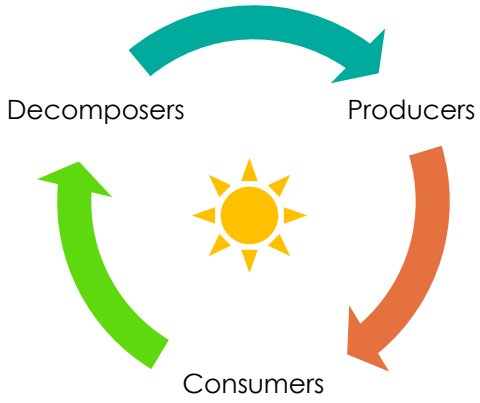


Fig.1. One-way cycle of Biotic components which function
with the support of Abiotic components and Sun as source of Energy
(Source: Science for Xth Class: Biology)

3. Conclusion

   If implementing Eco-designed approach in the field of Adaptive Façade Systems; the primary aim for the future sustainable targets should be to develop an eco-friendly and socio-responsive technologies.

   Which will be only possible when the Adaptive Façade Systems track design strategies which endeavor to mimic the philosophy of – "the self-sufficient unit in nature called Eco-system."

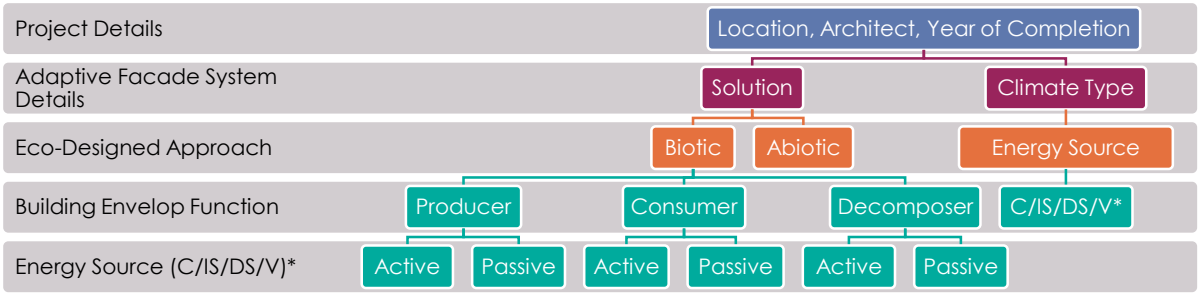
- **STEP:3**
  Outline a new holistic approach in the field of Adaptive Façade Systems:
  With the understanding of the future sustainable targets of adaptive systems and analyzing it's sustainably efficient elements with the help of already existing and scattered classification schemes (from the data base of 45 adaptive façade projects from Cost Action TU 1403-Adaptive Façade Network).

A new holistic approach is developed; titling: ECO-DESIGNED APPROACH - DESIGNING ADAPTIVE FACADES WITH A UNIFIED AND SYSTEMATIC CHARACTERIZATION.

This approach attempts to develop a novel matrix for re-analyzing the Adaptive Façade Projects with an Eco-designed approach. The aim of this approach is to examine whether the Adaptive Façade projects are able to seamlessly integrate with their natural environment (Climate Type).

Therefore, in this approach the functions of the adaptive façade projects is analyzed as an eco-system; characterized in a matrix as the Biotic components of Eco-system (Producer, Consumer and Decomposer) and Abiotic components of Eco-system (Air, Soil, Water, Temperature, Pressure, inorganic substances, etc.) which work in support of the natural sources of energy in the form of Conduction, Indirect-solar, Direct-solar and Ventilation.

Following is the matrix for analyzing the Eco-designed approach in the adaptive façade projects:

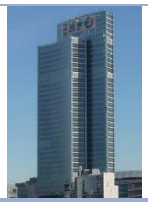
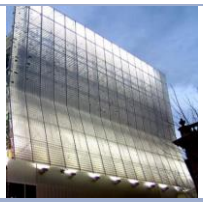
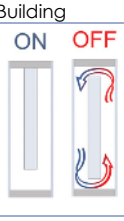


*Where; Heat Flow :
C = Conduction;
IS= Indirect Solar;
DS= Direct Solar;
V= Ventilation

Fig.2. Matrix developed for ECO-DESIGNED APPROACH –
Designing Adaptive Facades with a unified and systematic characterization.

- **STEP: 4**

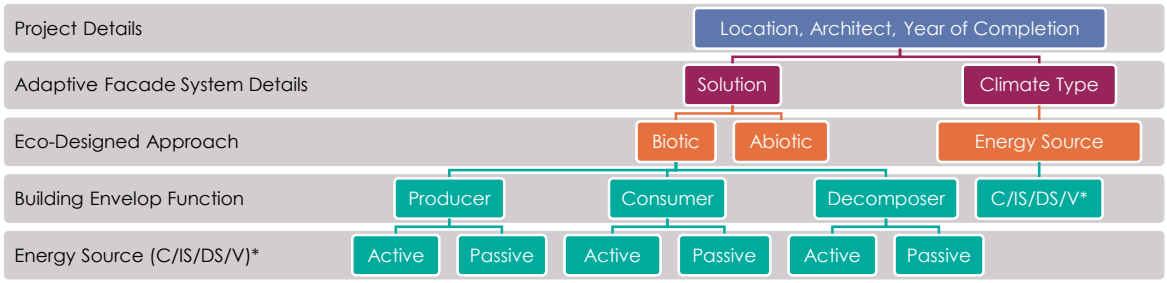
Inference; compilation and evaluation of the Adaptive Façade Projects under the matrix developed with this new holistic approach. Following are the list of projects and their comprehensive evaluation:

				
1. Oval Cologne Offices	2. Altra Sede Regione Lombardia	3. Articulated cloud Pittsburg Children Museum	4. ES Viagens Building/ PT Building	5. Campus Kolding, SDU University
				
6. Allianz Headquarters	7. Media-TIC	8. KfW Westarkade	9. WaMaFat - Switchable Insulation	

- **STEP: 5**
  Contribute to the content of Educational Pack
  This report on - ECO-DESIGNED APPROACH - DESIGNING ADAPTIVE FACADES WITH A UNIFIED AND SYSTEMATIC CHARACTERIZATION; envisions to achieve the sustainable targets of future developments with a new holistic approach and matrix. It targets to re-analyze and re-evaluate the adaptive façade systems with an Eco-designed approach.

  The contribution to the content of Educational Pack from this report should be the following:

  1. Novel matrix developed to achieve Eco-designed approach for designing adaptive facades with a unified and systematic characterization.



*Where; Heat Flow :
C = Conduction;
IS= Indirect Solar;
DS= Direct Solar;
V= Ventilation

  2. The final results of the evaluation of the 9 Adaptive Façade Projects from the database, which is as follows:

ECO-DESIGNED APPROACH – DESIGNING Adaptive Facades with a unified and systematic characterization.							
S.NO.	Project (Location) / (Efficiency = %*) Energy Source *Efficiency = (No. of Points achieved/ Total)%	BIOTIC COMPONENTS					
		Producer		Consumer		Decomposer	
		PASSIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE	ACTIVE
1	Oval Cologne Offices (Location: Cologne, Germany) / Efficiency = 67%						
	Direct Solar (83%)						
	Ventilation (50%)						
2	Altra Sede Regione Lombardia (Location: Milan, Italy) / Efficiency = 58%						
	Conduction (50%)						
	Indirect Solar (67%)						
3	Articulated cloud Pittsburg Children Museum (Location: Pittsburg, USA) / Efficiency = 17%						
	Ventilation (17%)						
4	ES Viagens Building/ PT Building (Location: Lisbon, Portugal) / Efficiency = 50%						
	Indirect Solar (50%)						
	Direct Solar (50%)						
5	Campus Kolding, SDU University (Location: Kolding, Denmark) / Efficiency = 67%						
	Direct Solar (83%)						
	Ventilation (50%)						

S.NO.	Project / Energy Source	BIOTIC COMPONENTS					
		Producer		Consumer		Decomposer	
		PASSIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE	ACTIVE
6	Allianz Headquarters (Location: Wallisellen, Switzerland) / Efficiency = 100%						
	Indirect Solar (100%)						
	Direct Solar (100%)						
7	Media-TIC (Location: Barcelona, Spain) / Efficiency = 67%						
	Indirect Solar (67%)						
	Direct Solar 67%						
8	KfW Westarkade (Location: Frankfurt, Germany) / Efficiency = 61%						
	Indirect Solar (50%)						
	Direct Solar (50%)						
	Ventilation (83%)						
9	WaMaFat - Switchable Insulation (Location: Ludwigshafen, Germany) / Efficiency = 67%						
	Conduction (67%)						

3. Additional Adaptive Façade Projects for the Educational Pack which have been developed with an Eco-designed approach:

A. **Project : LIVING ARCHITECTURE IS DEVELOPING BIOREACTOR BRICKS**



A house that can recycle wastewater and generate electricity from sunlight without the need of things like solar panels. Sounds too good to be true? Yet it might be possible in the near future.

The project Living Architecture (LIAR), coordinated by Newcastle University, is developing building blocks that can **extract resources from sunlight, wastewater and air with the use of microorganisms.**

Each block will contain a microbial fuel cell, which is filled with a variety of programmable synthetic microorganisms. Some will clean water; others reclaim phosphate, generate electricity or create new detergents. The living cells that will make up the wall will be able to sense their surroundings and respond to them through a series of digitally coordinated mechanisms. They can be robotically activated. The bricks are able to fit together and create 'bioreactor walls', which could be incorporated in housing, public buildings and office spaces.

The researchers also aim to find ways to reclaim phosphate, a mineral which is becoming increasingly scarce, and create new detergents using the blocks.

While this project deals with very small amounts of the substance, the insights that they will gather into how communities may collectively harvest reusable substances from their wastewater could potentially create an economy through

re-distributing resources through councils, or other interested parties such as washing machine manufacturers.

B. **Project: GROWING ECO-FRIENDLY BRICKS WITH SAND AND BACTERIA**



Start-up company BioMason is currently working towards a debut of a new kind of eco-friendly brick 'grown' with sand and bacteria. Based in North Carolina, they have already won numerous green construction industry awards for their innovative concept.

The construction industry currently accounts for around 40% of work emissions. Used in over 80% of building construction projects, bricks are a large contributor to this, generating approximately 800 million tons of carbon emissions per year, which more than the amount produced by all the planes in the world each year. That is a lot of pollution from one relatively simple material. BioMason hopes to change this.

The founder and CEO of this innovative company is Ginger Krieg Dosier. An architect by background, she has long been inspired by the process of biomimicry. **The inspiration for these bricks came from her study of coral reefs and the process of calcification that leads to their build up.** BioMason's eco-friendly bricks also use the natural process of calcification to gain their structure and strength. To create the bricks, sand is put into a mold and then inoculated with bacteria (Sporasarcina pasteurii). These bacteria are fed with calcium ions suspended in the water. The ions are attracted to the cell walls of the bacteria, creating in a calcium carbonate shell and the basis for a strong brick.

Unlike traditional bricks that requiring days of firing and produce large amounts of emissions as a result, **BioMason's biological bricks are grown in only two to three days – and they are emission free.** As an added bonus, Krieg Dosier adds that the bricks can actually even **absorb pollution and include other characteristics such as glow in the dark and color change properties.**

FUTURE COLLABORATIONS (if applicable)

In future collaboration (if applicable)the following could be the possibilities:

- Analysis of the other case studies under the derived matrix with an eco-designed approach can be continued.
- The database of Adaptive Façade Projects can be updated targeting the building materials or Façade design and construction systems which could be related with the theory of eco-designed approach.

- **The result of this STSM mission developed into an extensive approach. For future collaborations it attempts to produce a scientific paper for publication. Wherein, the scientific paper will attempt to develop the extended version of the same.**